A HEURISTIC DECISION MAKING MODEL TO MITIGATE ADVERSE CONSEQUENCES IN A NETWORK CENTRIC WARFARE / SENSE AND RESPOND SYSTEM

GRADUATE RESEARCH PROJECT

Maurice O. Alsing III, Captain, US ARMY

AFIT/MLM/ENS/05-01

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/MLM/ENS/05-01

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Maurice O. Alsing III,

Captain, US ARMY

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Maurice O. Alsing III,

Captain, US ARMY

Approved: Date

_____ _____

John E. Bell, Maj, USAF (Chairman)
Assistant Professor of Logistics Management
Department of Operational Sciences

Abstract

The general premise of this research is that decision making will increase in importance based on the transformation of the military towards Network Centric Warfare (NCW) / Sense and Respond logistical, informational, command / control systems. Additionally, this may result in an increase of adverse consequences, potentially resulting in an increase of accidents, major mishaps or, in general, system interruptions. Being able to quickly identify and mitigate adverse consequences in decision making will be more valuable and needed for managers and leaders in the near future. In the Legacy / cold war military, the need for information and decision making was mitigated by the large excess capacities, inventories, and redundant sub-systems and personnel or resources in general. Potentially in a NCW / Sense and Respond military there is a greater need for information and for decision makers to act or use the information, resulting in an increase in decision-making requirements. These may not increase in frequencies but rather increase in importance and impact as available resources are lessened and the information flow and amount increases, putting further demands on the decision makers. Also if the need to make decisions increases and, additionally, adverse consequences increase, the impact will be larger on the system with more implications, accidents, and system interruptions. It may be possible to mitigate or avoid the potentially negative impact of system interruptions and adverse consequences that stem from decision making in a NCW / Sense and Respond system. A model is suggested for considering decision consequences.

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A HEURISTIC DECISION MAKING MODEL TO MITIGATE ADVERSE CONSEQUENCES IN A NETWORK CENTRIC WARFARE / SENSE AND RESPOND SYSTEM

I. Introduction

Background

> *"One of the biggest challenges we face today is finding managers who can sense and respond to rapid shifts, people who can process new information very quickly and make decisions in real time. It's a problem for the computer industry as a whole-and not just for Dell-that the industry's growth has outpaced its ability to create managers"* (Magretta, 1998:83).

This chapter will address the background, problem statement, research question, investigative questions, proposed methodology, and limitations. The general premise of this research is that decision making will increase in importance based on the transformation of the military towards NCW / Sense and Respond logistical, informational, command / control systems, additionally resulting in an increase of adverse consequences, potentially resulting in an increase of accidents, major mishaps or in general system interruptions. Being able to quickly identify and mitigate adverse consequences in decision-making will be more valuable and needed for managers and leaders in the near future. The author defines an adverse consequence within the scope of this study as the negative result of an action or inaction as a result of a decision. Threats and adverse actions are different from adverse consequence in subtle and fundamental ways. Threats and adverse actions are negative *external* forces that interfere or obstruct the execution of the decision maker's plan or mission. With adverse consequences, the decision maker sets into motion events that lead to an unintended negative result or event.

The decision maker's plan and execution process itself is *internally* linked to the adverse consequence. It's like the difference between being sunburned and having a fever. To illustrate an example of adverse consequence as a result of decision-making, it is recommended to read the Appendix first. However, a short synopsis of the story is provided here. You receive a mission to remove a military bridge in a foreign country. There are a number of decisions that have to be made during the mission and depending on the courses of action, an adverse consequence may occur. The first link in the actions that could lead to the adverse consequence is to connect with the engineer unit that owns the bridge. The second link is digging out the bridge. Third is removing the bridge. The fourth is not posting warning signs or barricades that may cause civilians to fall into the ravine later that night coming home from farming their fields because they can't see that the bridge is out. Enough information is given in this carefully constructed hypothetical scenario that the decision maker can identify the adverse consequence as they are making decisions and executing those decisions. Other examples might include the Space Shuttle Columbia disaster, Abu Ghraib prison scandal, World Trade Center September, 2001 terrorist attacks, and the Exxon Valdez oil spill.

Some of the general benefits of NCW / Sense and Respond and other similar systems are a decrease in excess capacity, inventories, and redundancies with the increase of information.

> *"The end of the Cold War has radically changed the way the U.S. military operates. Major troop deployments have given way to smaller and more mobile joint task forces. This major operational change also demands a major logistical change. The Defense Department must find a way to integrate information across the four services, provide visibility across the entire supply chain, and reduce*

customer wait time. It hopes that new technology can accelerate this revolutionary transformation" (Lt. Gen. McDuffie et al, 2001:92).

Decision makers can use information as a tool to increase efficiencies and or responsiveness. This process is a system trade off: as information increases, potentially unneeded excess capacity and inventories shrink, but the less information available, the more capacity and inventories are required. Figure 1 illustrates that in the Legacy / cold war military, inventories, and excess capacity or *resources* in general were a stronger system driver than *information* and *decision making*. In the Legacy / cold war military, the need for information and decision making was mitigated by the large excess capacities, inventories, and redundant sub-systems and personnel or *resources* in general. Potentially in a NCW / Sense and Respond military there is a greater need for *information* and for decision makers to act or use the information resulting in an increase in *decision-making* requirements. For Figures 1 and 2, the author has conceptually shown the change in growing importance of decision making.

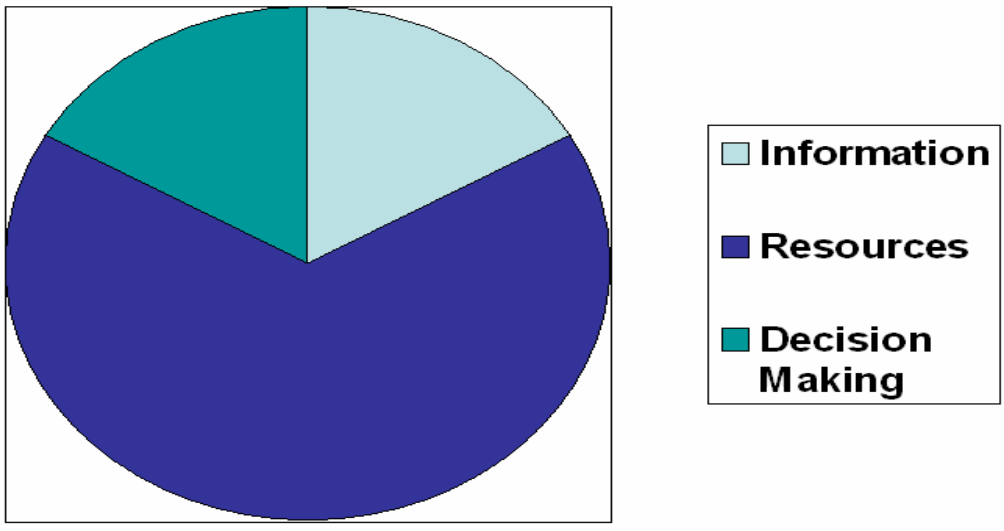

Figure 1. System Trade Off in Legacy / Cold War Military

Additionally, Figure 2 illustrates the general benefits of NCW / Sense and Respond and other similar systems with a decrease in excess capacity, inventories, redundancies or, in general, resources and an increase in information and decision making as system drivers.

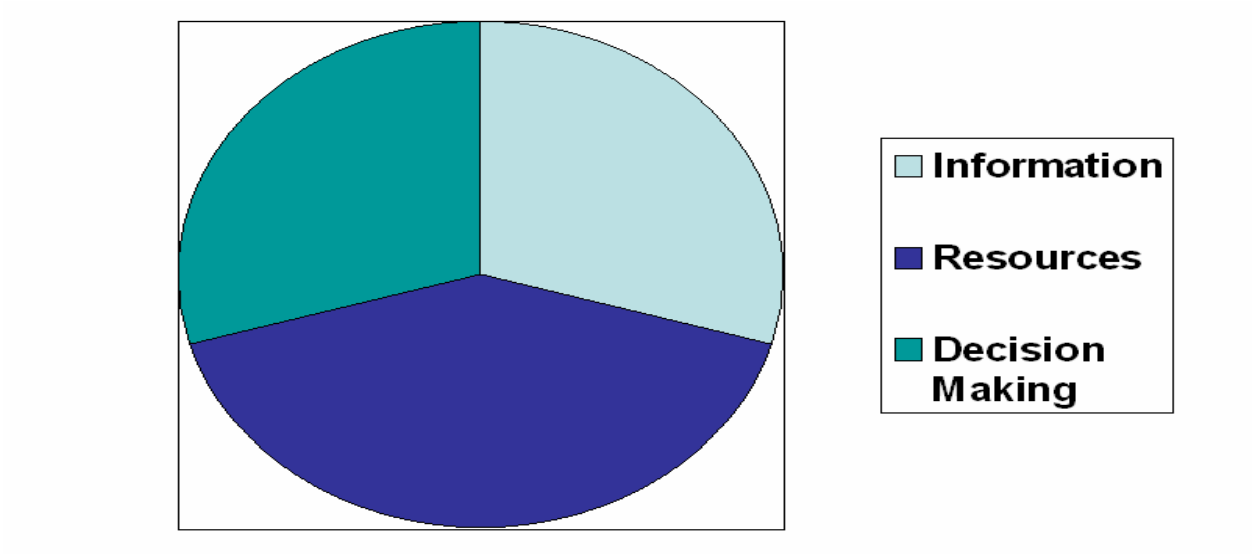

Figure 2. System Trade Off in NCW / Sense and Respond Military

Information potentially can make decision makers more informed and increase correct or prime decisions. (For the scope of this study, the author defines prime as meaning the same as best). However unintended, unforeseen consequences or adverse consequences resulting from decision making will potentially increase. Decision making requirements in a NCW / Sense and Respond system may not increase in frequencies but rather increase in importance and impact as available resources are lessened and the information flow and amount increases putting further demand on the decision makers. Also if the need to make decisions increases and, additionally, adverse consequences increase, the impact will be larger on the system with more implications, accidents, and system interruptions. It may be possible to mitigate or avoid the potentially negative

impact of system interruptions and adverse consequences that stem from decision making in a NCW / Sense and Respond system.

The military transformation from the legacy military to NCW is not complete and its outcome is unknown (Newkirk and Currie 2004). However, some general expectations can be drawn regarding decision making in a NCW system. NCW equates to more reliance on prime decision making. Additionally, there is less mitigation of decision errors in the NCW than in the legacy system because we lose the inefficient but large economies of scale to gain the efficient economies of information / data. NCW is a system designed to Sense or discover information / data and Respond to information / data (Lt. Gen. McDuffie et al, 2001). So we can expect that the military decision maker will have quick access to data that is of higher quality and scope in a NCW system than in the legacy military. In the legacy military, the decision maker spent most of his/her time gathering the data to make the decision. Now most of that burden does not fall on the decision maker and time is freed up to make decisions. NCW may even be able to help identify more unknowns to facilitate decision making. However, the decision maker will still be faced with the adverse consequences of the decisions that will be made regardless of the amount and quality of the data available. Additionally, adverse consequences will be more immediate and have potentially a larger detrimental impact since NCW relies more on prime decision-making with fewer backup resources.

Problem and Purpose Statement

Decision making is more important and has a larger impact in a NCW system. Mishaps or system disruptions also have a larger impact in a NCW system. NCW by design and in the context of this study attempts to be effective at identifying factors to

facilitate decision making. Unknowns will still be present in decision making in a NCW system. Little is presently known in regards to academic research whether military decision makers consider or analyze adverse consequences in decision-making processes, as opposed to assessing threats. However, it does seem very probable that decision makers do use some type of process to attempt to identify and mitigate adverse consequences but this process is not known. The purpose of this research is to examine whether the identification / analysis of unknowns and adverse consequences should be a function of prime decision making in a NCW system. And how and to what extent can the identification / analysis of adverse consequences be a part of prime decision making in a NCW system?

Research Question

Is there a need for military decision makers to identify / analyze adverse consequences as a function of the decision making process in a NCW system?

Investigative Questions

1. Is there a practical significance to the identification / analysis of adverse consequences in a NCW system?

2. What potentially will be the decision making process in a NCW system?

3. Will the decision-making process in a NCW system identify / analyze adverse consequences?

4. Do military decision makers identify / analyze adverse consequences presently?

5. How and to what extent can the identification / analysis of adverse consequences be a part of decision making in a NCW system?

These research questions at first may sound similar, but they are differentiated in important aspects. Question one is important; is there a value added need for managers / leaders to identify adverse consequences or is the process too complex for practical use.

Question 2 is important because; adverse consequences are due to decision-making and we have to attempt to identify what will be the decision making process in a NCW system before we can identify and mitigate adverse consequences in a NCW system. Question 3 is important because it is possible that a model / process to identify and mitigate adverse consequences has already been developed and will be apart of the decision making process in a NCW system. Question 4 is important because we can't begin to improve on decision-making and the identification and mitigation of adverse consequences in the future NCW system until we better understand how it is done presently. And question five is important; is it even possible to develop a working model / process to identify and mitigate adverse consequences in a NCW system and how can it be implemented?

Methodology

This research was completed in four phases. The first phase is the acquisition of qualitative research to address the investigative questions Q1, Q2, and Q3. The second phase is simulated theoretical models and processes to address the investigative question Q5. The third phase is a survey / designed experiment with statistical analysis to address the investigative questions Q4 and Q5. The fourth phase is the accumulation of the results of the investigative questions to answer the research question.

Summary

This chapter addressed the background, problem statement, research question, investigative questions, proposed methodology, and limitations. A brief review of relevant literature is next.

II. Literature Review

Introduction

> *"The main problem with making decisions is that decision makers do not take into account the consequences of their actions"* (Amend, 2004).

This chapter will address decision-making, threats and adverse actions, unknowns, uncertainty and risk, adverse consequences, prime decision-making, major mishaps, and the growing importance of the study of adverse consequences.

Decision Making

A decision is defined as "the means to achieve some result or to solve some problem; outcome of a process influenced by many forces" (Gibson et al, 2003). Defined by the author specifically within the scope of this study, decision making in general is a mental process of gathering data and based on the decision maker's knowledge, experience and value structure, a course of action or non action is identified, determined, and implemented. Theoretically, in a perfect information system, the decision maker could be totally informed in the context of the decision that has to be made and the quality of the decision would be based on the decision maker's knowledge and experience and would relatively make a prime decision. Gibson et al make the distinction between two types of decisions:

> *"Programmed decisions: If a particular situation occurs often, a routine procedure usually can be worked out for solving it. Thus, decisions are programmed to the extent that problems are repetitive and routine and a definite procedure has been developed for handling them. Nonprogrammed decisions: Decisions are nonprogrammed when they are novel and unstructured. No established procedure exists for handling the problem, either because it has not*

arisen in exactly the same manner before or because it is complex or extremely important. Such problems deserve special treatment" (Gibson et al, 2003).

For the scope of this study, any reference to a decision will be regarded as a nonprogrammed decision, for that is where the greatest potential for improvement and application exist.

Threats and Adverse Actions

The focus of this study, in part, is mitigating adverse consequences but it is important to understand its difference from threats and adverse actions. "A threat is a source of danger: any opposing force, condition, source, or *circumstance with the potential to impact mission accomplishment negatively* and/or degrade mission capability. Experience, common sense, and risk management tools help identify real or potential threats. Threat identification is the foundation of the entire risk management process; *if a threat is not identified it cannot be controlled.* The effort expended in identifying threats will have a multiplier effect on the impact of the total risk management process" (FM 3-100.12, 2003, emphasis added by author.) A risk management process involves the following:

- Identifying threats.
- Assessing threats to determine risk.
- Developing controls and making risk decisions.
- Implementing controls.
- Supervising and reviewing (FM 3-100.12, 2003).

The author has not been able to find research specifically in risk management of decision making that identifies adverse consequences as a "threat" despite its "potential to impact mission accomplishment negatively" (FM 3-100.12, 2003), nor any process to identify adverse consequences, nor a process to mitigate or avoid adverse consequences.

Unknowns

Hypothetically, if the decision maker does not have access to all information in the context of the decision that has to be made, then unknown factors exist that could interfere with the goal, plan, mission of the prime decision itself and the identification / mitigation of these unknown factors and threats are the center to the study of risk management. Unidentified risk is defined as "the risk that has not been identified. It is unknown or immeasurable" (FM 3-100.12, 2003). Presently it would seem from the lack of research on adverse consequences that it might fall under this definition as an unidentified risk and, in part, it is the focus of this study to examine possible value in the identification and mitigation / avoidance of adverse consequences.

Uncertainty and Risk

There has been a great deal of research on uncertainty and risk in the finance literature. In finance, uncertainty is defined as, "a state of not knowing whether a proposition is true or false" (Holton, 2004:23). Risk is defined as "exposure to a proposition of which one is uncertain" (Holton, 2004:23). However there is academic debate whether risk can be operationally defined?

> *"What is risk? How can we quantify risks that cannot be perceived? …Subjective probability, utility, and state preferences are tools for characterizing the uncertainty and exposure components of risk. Such tools are limited by the fact that they apply only to those aspects of risk that are perceived. Operationalism suggests that this problem is insurmountable. Because operational definitions apply only to that which can be perceived, we can never operationally define risk. At best, we can operationally define only our perception of risk. A more manageable task is to operationally define some aspects of perceived risk"* (Holton, 2004:24).

This article demonstrates that financial institutions use, in part, probability statistics as a key tool to mitigate perceived risk and do not attempt to identify unperceived risks. This process would not help a manager or leader to identify / mitigate adverse consequence in decision making due to time constraints. It is at the heart of this study to mitigate unperceived risks for risk is a part of adverse consequence. The decision maker is indeed *exposed to a proposition that was uncertain* when an adverse consequence occurs in decision making.

Adverse Consequences

Theoretically, if we were ever able to obtain a perfectly-optimized, decision-making process with access to instantaneous and total information to identify all threats and adverse actions, the system would still be at risk to adverse consequences. Relevant research has been done in the attempt to identify adverse consequences and to mitigate them specific to the life cycles involved with military acquisition and NASA's engineered projects. The Department of Defense attempts to mitigate adverse consequences regarding the life cycles of the systems that they acquire by basically appointing a panel of experts specific to the system of interest to identify potential future problems and acceptable tolerance levels of the system before acquisition (Office of the Under Secretary of Defense, 1999). This does not fall within managerial or leadership decision making, but does demonstrate an attempt to mitigate the potential adverse consequences of acquiring systems that are less than optimal. Additionally, it demonstrates the potential for experience as being important to identifying adverse consequences. NASA developed a process to mitigate adverse consequences regarding the life cycles of complex engineered projects by using Probability Risk Assessment or

PRA (Stamatelatos, 2000). Dr Stamatelatos defines PRA as "a systematic and comprehensive methodology to evaluate risks associated with every life-cycle aspect of a complex, engineered, technological entity (e.g., facility, spacecraft, or power plant) from concept definition, through design, construction and operation, and up to removal from service." Probabilistic Risk Assessment usually answers three basic questions:

- What can go wrong with the studied technological entity, or what are the initiators or initiating events (undesirable starting events) that lead to adverse consequence(s)?
- What and how severe are the potential detriments, or the adverse consequences that the technological entity may be eventually subjected to as a result of the occurrence of the initiator?
- How likely to occur are these undesirable consequences, or what are their probabilities or frequencies (Stamatelatos, 2000)?

Dr Stamatelatos describes the process of how to answer these questions. "The answer to the first question requires technical knowledge of the possible causes leading to detrimental outcomes of a given activity or action. The answers to the second and third questions are obtained by developing and quantifying accident (or mishap) scenarios, which are chains of events that link the initiator to the end-point detrimental consequences" (Stamatelatos, 2000). Thus, to identify the "initiators or initiating events (undesirable starting events) that lead to adverse consequence(s)" (Stamatelatos, 2000), NASA is using technical or expert knowledge as well as DoD Acquisitions to attempt to identify and mitigate adverse consequences. It is important to note that for both NASA and DoD Acquisitions that the initiators or undesirable starting events emanate from *physical* system platforms and engineered entities as opposed to adverse consequence in decision making which stems, ultimately from a *mental* thought process. For the purpose

of this study initiators or initiating events will be termed Chained Event Points (CEPs) and Chained Unknown Event Points (CUEPs).

Prime Decision Making

Historically and doctrinally the military has used a formalized or abbreviated (for time constraints) form of a quantitative process known as the Military Decision Making Process (MDMP). A resent study has shown that MDMP is not conducive to NCW (Ross et al, 2004). Resent research on the Recognition-Primed Decision Model (RPD) has shown it to be more intuitive, faster and more effective in use than MDMP (Ross et al, 2004). MDMP looks at the pros and cons of three alternative courses of action but does not appear to seek to identify the adverse consequences of the decisions themselves. Recognition-Primed Decision Model (RPD) is more intuitive and looks at one course of action but does not specifically look at adverse consequences either.

Perhaps decision makers attempt to identify the adverse consequences or some of the adverse consequences when they make decisions or perhaps they do not. No research was found about whether decision makers attempt and, if so to what extent, or do not attempt to identify the adverse consequences of a decision.

Major Mishaps

The study and analysis of military decision-making and adverse consequences are relevant. Here are the identified factors that led to Air Force major accidents and mishaps in one year. The three factors will be used as examples of how decisions that are made can lead to an adverse consequence. The recent Air Force study showed that the *three leading factors* that resulted in major mishaps or accidents were Inadequate Supervision, Judgment / Decision Error, and Attention / Memory Error (Krulak, 2004).

Specifically within the context of this study, the major mishaps would be adverse consequences stemming from a decision that was made and the *three leading identified factors* that lead to the mishaps are examples of and are defined here as Chained Unknown Event Points. With the first factor of Inadequate Supervision, the decision maker or leader did not provide adequate supervision, which led to a major mishap or adverse consequence. The second factor that resulted in the major mishaps or accidents is Judgment / Decision Error and is specifically a condition where the decision maker did not identify the adverse consequence of the decision nor attempt to mitigate or avoid it. The third factor that led to major mishaps is Attention / Memory Error. Under this condition, the decision maker made a decision without taking into consideration the consequence of the actions. It is assumed that the decision maker should have known the adverse consequence of the action but the lack of attention or forgetfulness interfered with the decision maker's ability to identify the adverse consequence.

Black Holes

Black holes are unknowns. Yet we still manage to identify them. If we can't see them, how do we know they are there?

> *"Since black holes are small (only a few to a few tens of kilometers in size), and light that would allow us to see them cannot escape, a black hole floating alone in space would be hard, if not impossible, to see…However, if a black hole passes through a cloud of interstellar matter or is close to another "normal" star, the black hole can accrete matter into itself. As the matter falls or is pulled towards the black hole, it gains kinetic energy, heats up and is squeezed by tidal forces. The heating ionizes the atoms, and when the atoms reach a few million degrees Kelvin, they emit X-rays. The X-rays are sent off into space before the matter crosses the Schwarzschild radius and crashes into the singularity. Thus we can see this X-ray emission"* (Newman, 2005).

So we can identify unknowns like black holes by observing their impact or interaction with detectable energy around it. Perhaps unperceived risk, uncertain conditions, threats and adverse actions, and unknowns in general can be identified instead of improperly attempting to identify them directly but rather identify their impact or interaction with the operational environment as they are linked in a chain of events that lead to an adverse consequence. By reasoning what realistic and probabilistic adverse consequence may occur as a result of a decision, unknowns can be anticipated and mitigated. This heuristic technique is the premise of the model / process of this study.

Growing Importance

The study and analysis of military decision-making and adverse consequences are important. Under the legacy military or the military up to Operation Desert Storm, the military relied on large inventories of supply, mass of scale, mass of equipment, personnel redundancies, incremental assigned duties, large stove piped bureaucracy and systems which hampered efficiency but mitigated decision errors in general. However, with the transformation of the military, the ability of a military decision maker to make prime decisions will increase in importance.

> *"We must match the warfighter's speed, flexibility, and responsiveness with seamless and agile logistics. In this way, we will bring together the successes of Operation Iraqi Freedom to create true end-to-end visibility. Today's logisticians must develop real-time management and integration of knowledge-enabled logistics, because tomorrow our military may again be required to operate in austere environments at rapid tempos similar to those experienced in OIF"* (Estevez and Geary, 2004:42).

The military is transforming towards modular capabilities as a function of exploiting information and technology to respond to discontinuous change at the

strategic, tactical, and operational levels (Alberts et al, 1999; Haeckel, 1999). Commonly, in the military, this process is termed Network Centric Warfare and Modularization and is synonymous with the emerging business theory and practice of Sense and Respond (Bradley and Nolan, 1998). The term NCW will be used for this kind of system. However, an important aspect of Sense and Respond has been identified as "…the capacity of humans to think outside the system context to respond to discontinuous change" (Hackle, 1999). Thus, an important aspect of NCW is the capacity of military decision markers to make prime military decisions outside the system context to respond to a dynamic or volatile environment.

Summary

This chapter addressed decision making, threats and adverse actions, unknowns, uncertainty and risk, adverse consequences, prime decision making, major mishaps, and the growing importance of the study of adverse consequences. The research described in the next chapter is a step in what appears to be a need for understanding how decisions result in adverse consequences.

III. Methodology

Introduction

This chapter will address the purpose statement, research paradigm, theoretical model, and experimental design.

Purpose Statement

The purpose of this research is to identify if there is a need for military decision makers to identify / analyze adverse consequences as a function of the decision-making process used in a NCW system and propose a model for doing so, if found to be true.

Research Paradigm

The research will be a qualitative and quantitative hybrid analysis using a developmental and designed experimental approach to investigate: is there a practical significance to the identification / analysis of adverse consequences in a NCW system; what will be the decision-making process in a NCW system; will this decision-making process identify / analyze adverse consequences? The results will be used to assess whether military decision makers identify / analyze adverse consequences presently. A model is proposed to show how and to what extent the identification / analysis of adverse consequences can be a part of decision making in a NCW system.

The five investigative questions (Q1-Q5) are:

1. Is there a practical significance to the identification / analysis of adverse consequences in a NCW system?
2. What potentially will be the decision-making process in a NCW system?
3. Will the decision-making process in a NCW system identify / analyze adverse consequences?

4. Do military decision makers identify / analyze adverse consequences presently?

5. How and to what extent can the identification / analysis of adverse consequences be a part of decision making in a NCW system?

Theoretical Model

Variables.

The variable of interest was the correct identification of the adverse consequence. The variable was binary; with zero denoting that the test participant did not identify the adverse consequence and one denoting a correct identification of the adverse consequence.

Experimental Design.

The sample consisted of two groups, a test and a control group. Each was given the same hypothetical situation. The sample consisted of military officers attending graduate school. The carefully constructed situation consisted of four factors that led to an adverse consequence. Results were compiled and analyzed.

Research Design

Phase I.

The first phase was the acquisition of qualitative research to address the investigative questions Q1, Q2, and Q3. Additionally, conceptual models were built to capture the process of a base line model which represented the present normal or standard process of identifying and mitigating adverse consequences in decision making and an alternative conceptual model which consisted of an alternative process for identifying and mitigating adverse consequences in decision making.

Phase II.

The second phase was simulating the theoretical models and processes to address investigative question Q5. The simulated results provided important information on the processes and robustness of the models to help design the experimental models. The simulation of the conceptual models processes used Arena 5.0 Standard edition Simulation Software to develop, analyze, verify and compare the robustness and abilities of the models. Additionally, this potentially will provide data for the future research of this study area.

Phase III.

The third phase was a survey / designed experiment with statistical analysis to address the investigative questions Q4 and Q5. The designed experiment data should demonstrate the viability of the alternative model and give further insight into the process of identifying and mitigating adverse consequences in decision making. The sample consists of two groups that were given a hypothetical situation. Each individual was a decision maker tasked with making decisions. There were two survey / designed experiment versions (1A, 1B). Both treatments were identical except 1A included special instructions, both written and verbal, that represented the alternative model. Each Survey was randomly distributed. The situations consisted of four Chained Unknown Event Points (CUEPs). These carefully constructed situations required a decision and included were factors that led to an adverse consequence. Results were compiled and analyzed for a general comparison of means and an analysis of variance (ANOVA) to determine statistical significance using JUMP. The ANOVA results were verified with a Logit Loglinear Analysis using Minitab.

Phase IV.

The fourth phase is the accumulation of the results of the investigative questions to answer the overall research question.

Summary

This chapter addressed the purpose statement, research paradigm, theoretical model, and experimental design.

IV. Results and Analysis

Overview

The purpose of this research is to identify if there is a need for military decision makers to identify / analyze adverse consequences (ACs) as a function of the decision-making process in a NCW system and to propose a model for doing so if found to be so. This research was completed in three phases. The fourth will be addressed at the end of this chapter and will attempt to answer the research question.

Phase I.

The first phase will attempt to answer the investigative questions Q1, Q2, and Q3. And the conceptual base line and alternative models will be presented.

1. Is there a practical significance to the identification / analysis of adverse consequences in a NCW system?

The answer to investigative question Q1 is YES. Based on the research in the literature review, potentially adverse consequences will increase as decision making and information increases in a NCW system (Estevez and Geary, 2004; Magretta, 1998). The practical significance is that managers and leaders will potentially be able to mitigate the ACs and be more effective at making decisions. Major mishaps and accidents will be potentially reduced.

2. What potentially will be the decision making process in a NCW system?

Decision makers will have little time to make decisions and react to changes (Estevez and Geary, 2004; Magretta, 1998). The current Military Decision Making Process (MDMP) has been shown not to be as fast as Recognition-Primed Decision Model (RPD) (Ross et al, 2004). The answer to investigative question Q2 is that RPD or

an equivalent process most likely will be the official or doctrinal decision-making process of the military in a NCW system.

3. Will the decision-making process in NCW identify / analyze adverse consequences?

The answer to investigative question Q3 is NO, not at this time. MDMP and RPD do not incorporate a process to identify and mitigate ACs. In general, there is a hole in the research and the process of risk assessment and decision making in providing a process for decision makers to identify and mitigate ACs. NASA, DoD Acquisitions, and financial institutions all use differing methods to attempt to mitigate ACs such as appointing an expert panel, technical expert evaluation, using historical data, and probability statistics to identify high risk financial ventures and the life cycles of system platforms / complex engineered projects. However, these processes do not appear to be specifically conducive to the needs of managers and leaders potentially in a NCW system.

The Models.

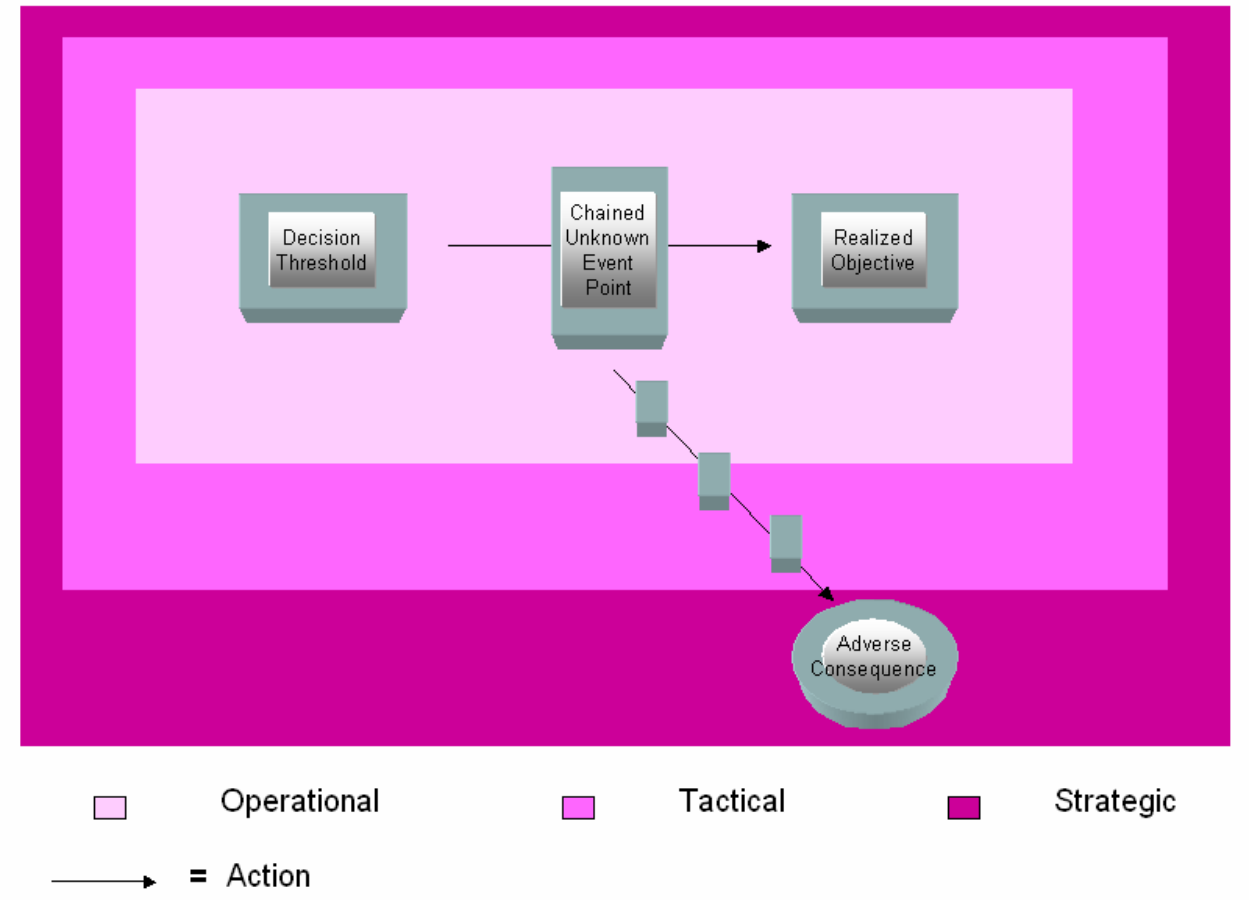

Figure 3. Base Line Model

Figures 3 depicts the basic model and consists of the decision threshold or event just before a plan turns into action or is executed, which the arrow represents. Before the plan can be realized or the objective met, the action can trigger an unknown event point or set into motion a chain of unknown event points (CUEPs) that manifest into or lead to an adverse consequence in either the operational, tactical, or strategic level. The main drawback with the base line model is that for the most part, the adverse consequence remains unknown to the decision maker and only the first few chained unknown event

points can be or are realized. Thus, the decision maker isn't aware that the actions are leading to an adverse consequence.

Figure 3a depicts the alternative model and process. Potentially, unperceived risk, uncertain conditions, threats and adverse actions, and unknowns in general can be identified. Instead of improperly attempting to identify them directly, the decision maker should understand that the events are linked in a chain that leads to an adverse consequence. By reasoning what realistic and probabilistic adverse consequence may occur as a result of a decision, unknowns can be anticipated and mitigated. The model identifies the complete chained unknown event points by first attempting to identify the most likely adverse consequence within the context of the operational, tactical, and strategic mission.

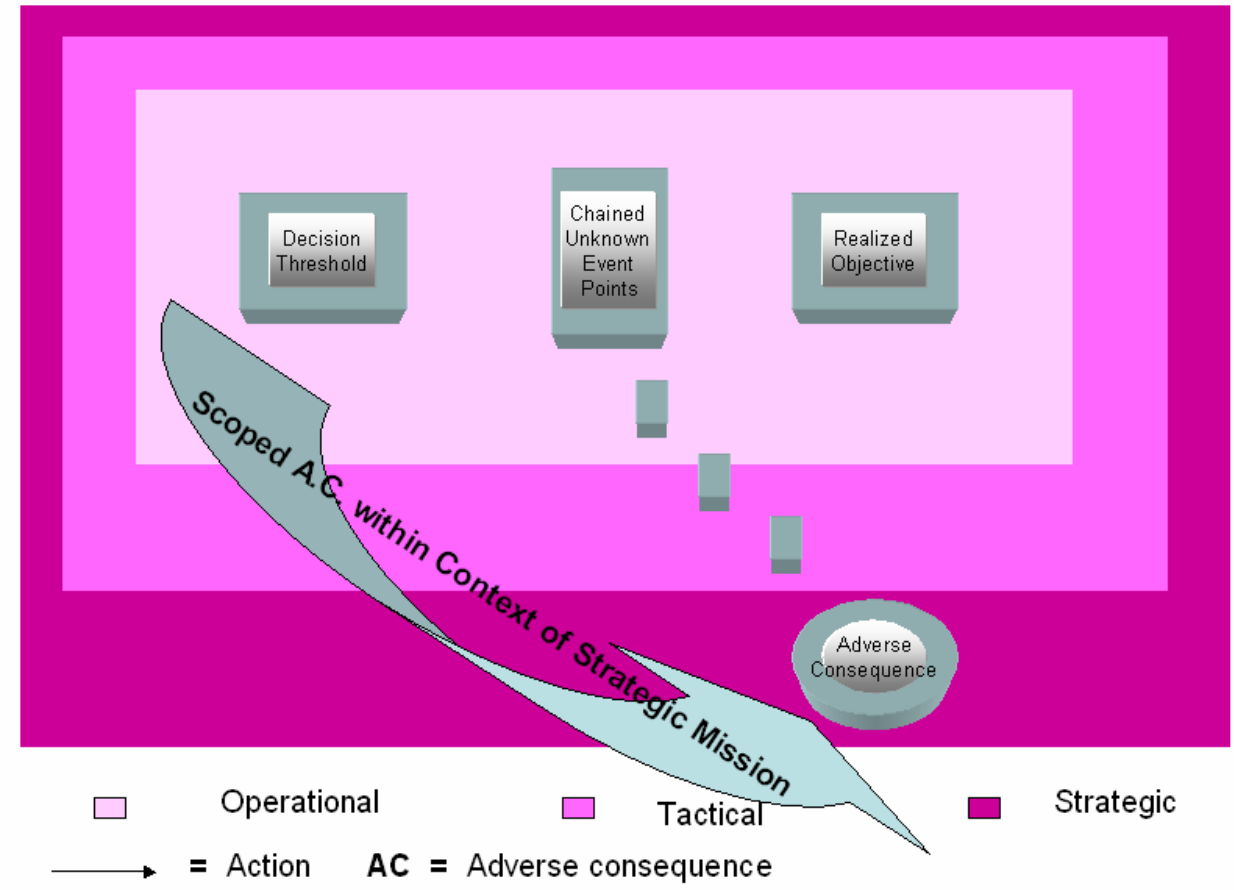

Figure 3a. Alternative Model and Process

While unknown factors can interfere and exist within the context of the decision itself, the adverse consequences (ACs) are connected to the factors leading back to the decision and can be manifested outside the context of the decision maker's local or operational viewpoint. Additionally, from the decision maker's local viewpoint, the manifestation of an adverse consequence may seem paradoxical in the base line model as the decision maker is gathering and analyzing information only within the operational view. In the base line model, the decision maker executes a plan based on a decision and sets into motion a chain of events that lead to an AC and the AC can negatively impact

the strategic mission. The decision maker may not even realize the final impact of the decision even though the decision may have been a best-prime decision at the operational or tactical level. So this gives rise to two important aspects of ACs. One is that they are linked by events points of actions back to the decision itself and two is that the AC can negatively impact the system at any level: operational, tactical or strategic. It can also manifest at the national level; for the purpose of this study, strategic and national are considered the same.

Figure 3b depicts reverse mapping of the chained unknown event points (CUEPs) back to the decision / action. Thus, the decision maker is able to anticipate the AC and mitigate or avoid the AC as shown in the final alternative model figure 3c.

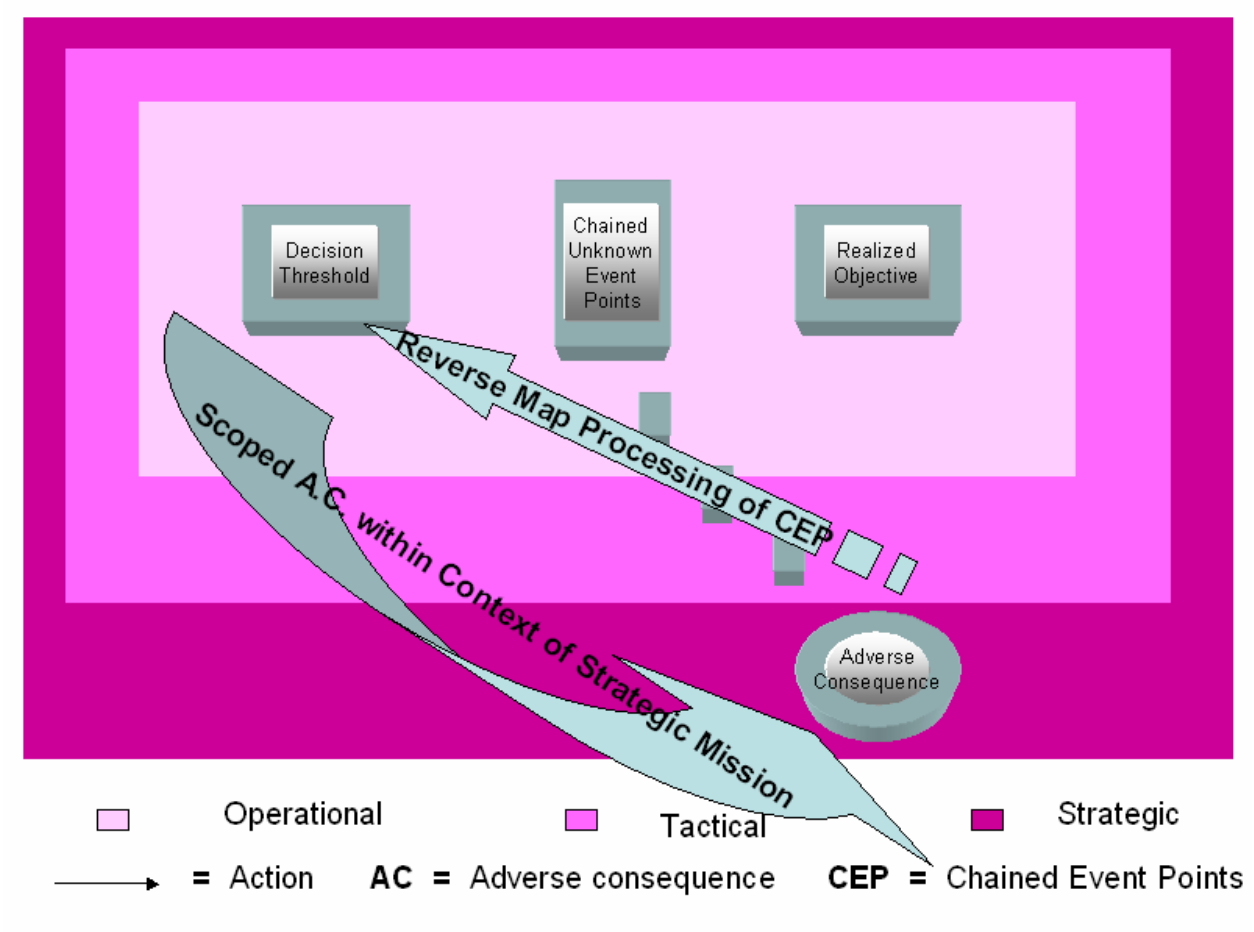

Figure 3b. Alternative Model and Process Continued

Unknowns are the ultimate confounding variable. The identification and analysis of unknowns outside of the contextual bounds of relevance and probability is unproductive. In simpler words, we don't and shouldn't care if we go outside to get the newspaper and that this action may put into motion events that lead to the remote possibility of a meteor striking the Earth. The decision maker should narrow the *scope* to identifying the AC within the context of their operational, tactical, and strategic plan or missions. For an example of how the operational plan or mission can create an AC that adversely affects the strategic mission, see the Appendix.

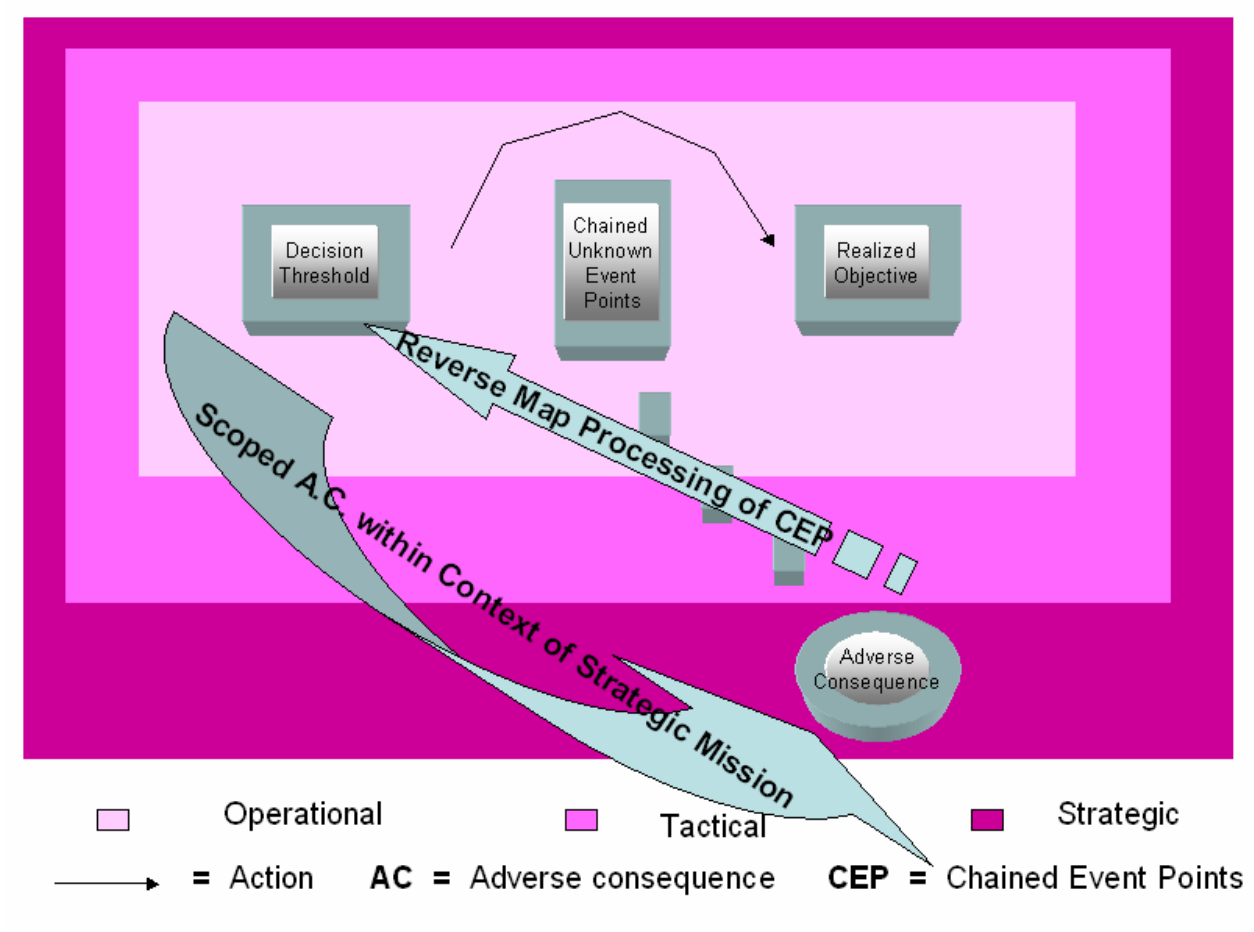

Figure 3c. Alternative Model

The AC should also be scoped by the realistic probability and potential severity of the AC. This was borrowed from NASA's Probability Risk Assessment or PRA (Stamatelatos, 2000). As opposed to NASA's PRA, this process is a purely heuristic step where each individual decision maker will scope the AC according to his or her individual knowledge, experience, and values. Managers and leaders do not have large amounts of time especially in an NCW system. This model could include statistical probability methods to assist in scoping the AC but may be unrealistic in application to help managers in the decision-making process due to time limitations on managers and leaders. It is important in the process to know that for every AC there are actual chains

of unknown factors, actions or event points (CUEPs) that manifest the AC. Understanding that if the potential chain of unknown factors or event points determines the AC, then at any point if the chain of unknown factors (CUEPs) is broken the adverse consequence cannot be manifested, relatively with everything else being equal.

"Process mapping tends to break down a process into activities and steps. Every step includes information to characterize the system being mapped" (Gardner and Cooper, 2003:45). The CUEPs are linked together and flow to the manifestation of the AC; it is by identifying the AC and backtracking or *reverse mapping* of the CUEPs that unknown factors can be identified and mitigated, such as thinking about peasants falling into the ravine and putting up signs to warn them. Hindsight may be 20/20, but foresight can also be 20/20. The alternative model in part attempts to achieve the same or similar results before the AC has occurred and during the process of decision making. Once the CUEPs have been identified, they are termed Chained Event Points (CEPs). Thus, the vast range of potential unknowns or CUEPs that lay in wait at the threshold of any decision can be potentially identified by scoping the AC and reverse mapping of the CUEPs. When these previous unknowns are identified as CEPs, the decision maker can mitigate or avoid the AC itself and complete the mission, goal, or objective. The arrow in the figure 3c represents this last process.

Phase II.

The second phase is simulated theoretical models and processes to address the investigative question Q5. The simulation of the conceptual models' processes used Arena 5.0 Standard edition Simulation Software to develop, analyze, verify and compare

the robustness and abilities of the models. Additionally, this provides valuable data for the potential future research of this study.

5. How and to what extent can the identification / analysis of adverse consequences be a part of decision making in a NCW system?

The investigative Q5 will be answered in phase four. However we can gain information regarding how and to what extent the identification / analysis of adverse consequences can be a part of decision making in a NCW system by identifying and analyzing the theoretical simulation of the model's processes.

Simulation of the Models

Phase two consisted of theoretically simulating the base line and alternative model processes specific to the identification or non-identification of the AC. The theoretical basic simulation model, as seen in figure 4, has a random distribution to represent that purely by chance the decision maker would be able to identify an unknown event point or points (CUEPs) and tie them together as leading to the AC.

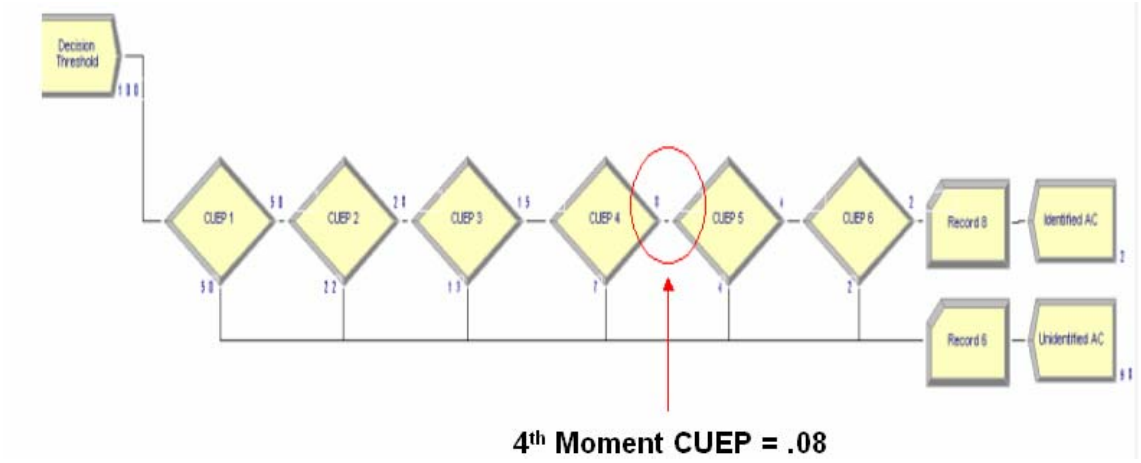

Figure 4. Base Line Model Simulation

The assigned distribution for the basic model was random at a 50/50 distribution. At each CUEP away from the decision, it becomes harder and less likely to identify the

AC and accordingly declines exponentially and ends in all practicality at the sixth CUEP with .02 or 2% chance of identification. This demonstrates what the model can handle before the decision maker has no relative chance of randomly identifying the AC. The simulation shows that 8% of decision makers using the base line model would identify the AC with four CUEPs or rather at the 4th moment CUEP and virtually reaching zero at the sixth CUEP. The assumptions are that perhaps experience would play a significant role and increase the chance of identifying the AC but we have no research or data on the decision maker's ability to identify an AC so random would be appropriate and was selected for the basic model.

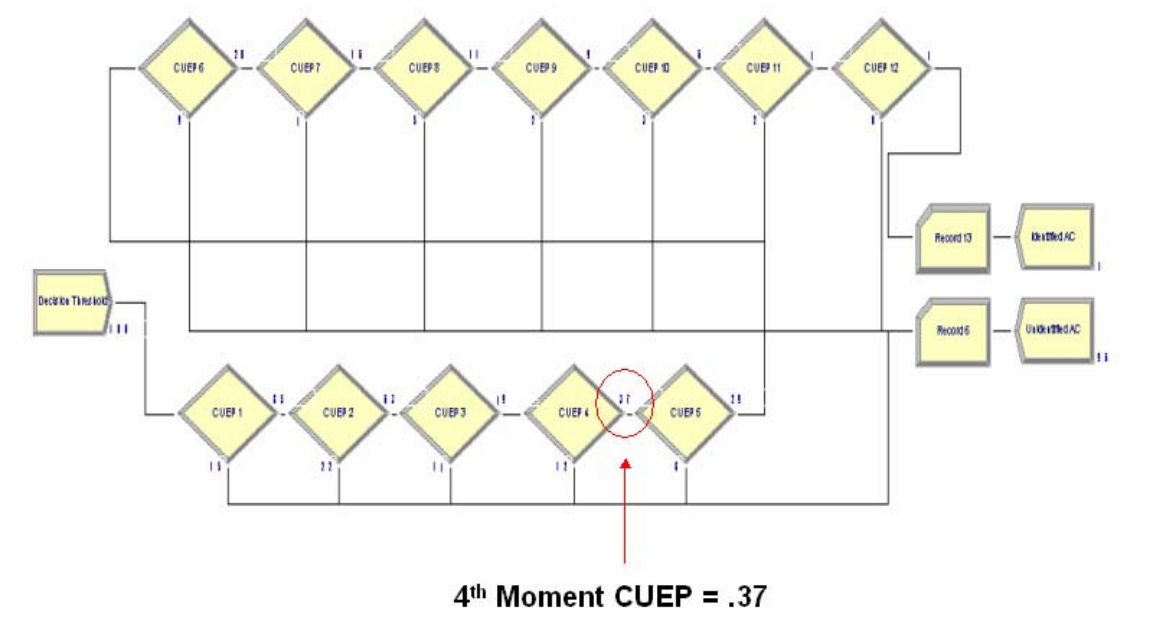

Figure 5. Alternative Model Simulation

The theoretical alternative model distribution would have a greater chance of identifying the AC because that's what the alternative model does. First the decision maker scopes the AC in the context of the operational, tactical, and strategic missions and based on probability / severity. Then the CUEPs that have to take place for the adverse

consequence to occur are reverse mapped. The distribution that was assigned is based on the Pareto 80 / 20 rule. Theoretically, there is no reason that this model should not have a 100 percent correct identification at the 4th moment CUEP. But realistically, managerial decision makers are human and the selection of the 80 / 20 distribution is an attempt to try and capture basic human error. With this distribution, the alternative model is much more robust and reaches its practical limit at the 12 CUEP. The simulation shows that 37% of decision makers using the alternative model would potentially identify the AC with four CUEPs or rather at the 4th moment CUEP and virtually reaching zero at the 12 CUEP. This indicates that potentially decision makers will have the ability to handle more complex scenarios and still identify the AC. This section presented a simulation of the models' processes and the ratios 50/50 and 80/20 are for illustrative purposes until they can be compared with the designed experiment results.

Phase III.

The third phase consists of a survey / designed experiment with statistical analysis to address the investigative questions Q4 and Q5.

4. Do military decision makers identify / analyze adverse consequences presently?

The answer to investigative question Q4 is NO based on the survey results. 14 of the participants in the survey indicated that they use some type of heuristics in making decisions (see Table 3 presented later). Four participants indicated that they use a quantitative model or process. Most likely this quantitative model and process is MDMP but that question was not asked directly. The results from the experiment show that four participants were able to identify the designed AC. None of the four participants that identified the AC indicated that they used a quantitative model or process in decision

making. One participant from the base line model group identified the AC, which is consistent with the results from the simulation base line model with a random 50/50 distribution. These results indicate that the decision makers were not effective at identifying the AC in the experimental exercise. We have shown from the literature review that MDMP and the probable future decision-making process of PRA do not attempt to identify / analyze ACs. Results indicate that most decision makers do not use a formal process to identify / analyze ACs. Those participants that reported they do use a quantitative process / model in decision-making were unable to identify the AC.

5. How and to what extent can the identification / analysis of adverse consequences be a part of decision making in a NCW system?

The identification / analysis of ACs can be a part of decision making in a NCW system. The results of the designed experiment indicate that the alternative model results in, conservatively, a 29% improvement in the decision makers' ability to identify the AC at the 4th moment CUEP and mitigate the AC. Incorporating the alternative model into managerial risk assessments and decision-making processes can substantially increase the identification of ACs. Using the model's process steps, managers can be trained to be more effective at identifying and mitigating ACs. Experience, knowledge, and values are important in making decisions. If we could teach managers to consider ACs early, they will potentially become even more adept at identifying and mitigating ACs. This could help managers to be better prepared for the decision making challenges in a Network Centric Warfare / Sense and Respond environment.

Goodness of Fit.

Input analysis and a goodness of fit test were conducted. Responses by the base line group are distributed Weibull (8 no, 1 yes) and by the alternative group are distributed Triangular (6 no, 3 yes). This information may be helpful for possible future research regarding these models.

Designed Experiment

The designed experiment is a hypothetical decision making scenario questionnaire with an imbedded AC with four CUEPs. Each group originally had 15 participants. Nine participants from each group completed and turned in the designed experiment. Both questionnaires were the same except for alternative group 1A whose instructions were to consider adverse or unintended consequences of their decisions within the context of their operational, tactical, and strategic missions. In other words, the alternate model was verbalized and instructed to one group as well as having a sentence at the beginning of the questionnaire. The special instructions that verbally represented the alternative model said, "*Before you make a decision take into account your strategic, tactical, and operational missions and consider what in the context of the mission that is being accomplished would be an unintended or adverse consequence of the execution of the decision and how can it be avoided."* The base line model group was not given special instructions (See Appendix). Consistent with the conceptual and simulated models, the designed experiment models consisted of the 4th moment CUEP. The AC could only occur if the CUEPs were realized or chosen by the participants. Additionally, the decision maker / experimental participant could have identified the AC at previous CUEP levels and acted to mitigate the AC. The four CUEPs are as follow.

- 1st Moment CUEP = link up with engineer unit
- 2nd = dig out bridge
- 3rd = remove bridge
- 4th / AC = no signs put up so civilians fall into ravine

Tables 1 and 2 present the results from the designed experiment. Designed experiment alternative group 1A had three participants identify the AC and the basic group 1B had one participant identify the adverse consequence at the 4th moment CUEP. Comparing the theoretical simulated base line model at the 4th CUEP we find a value of .08 and the designed experiment base line model group had a value of .111. So 8% of decision makers in the simulated base line model identified the AC at the 4th moment CUEP and potentially we would expect the results from the designed experiment base line group to be similar and they are statistically similar at 11%. As shown in Figure 5, the simulated alternative model at 4th moment CUEP had a value of .37 and the designed experiment alternative model group scored .33. Again we find the alternative model statistically similar in both the simulated model and the designed experiment model. Potentially the alternative model is 22% more successful and twice as robust at identifying the AC and the decision maker can handle more complex decision making scenarios up to the 12th moment CUEP.

Table 1. Designed Experiment Results Base Line Group

Group 1B	CA	SPT	DM: Y	DMI: Y	DM: H	DM: Q	ID AC
Participants							
1		Y	Y	Y	Y		
2		Y	Y	Y		Y	
3		Y	Y	Y	Y		
4		Y	Y	Y	Y		
5		Y	Y	Y	Y		
6		Y	Y	Y	Y		Y
7		Y	Y	Y	Y		
8		Y	Y	Y	Y		
9		Y	Y	Y		Y	
Total	**0**	**9**	**9**	**9**	**7**	**2**	**1**
Mean	**0.00**	**1.00**	**1.00**	**1.00**	**0.78**	**0.22**	**0.11**
%	**0**	**100**	**100**	**100**	**78**	**22**	**11**

CA = Combat Arms **SPT** = Support **DM: Y** = Yes I Am a Decision Maker

DMI: Y = Yes Decision Making is Important **DM: H** = Use Heuristic Decision Making

DM: Q = Use Quantitative Process Decision Making **ID AC** = IDed Adverse Consequences

Table 2. Designed Experiment Results Alternative Group

Group 1A	CA	SPT	DM: Y	DMI: Y	DM: H	DM: Q	ID AC
Participants							
1		Y	Y	Y		Y	
2	Y	Y	Y	Y		Y	
3			Y	Y	Y		
4		Y	Y	Y	Y		Y
5		Y		Y	Y		
6		Y	Y	Y	Y		Y
7	Y		Y	Y	Y		
8		Y	Y	Y	Y		
9		Y	Y	Y	Y		Y
Total	**2**	**7**	**8**	**9**	**7**	**2**	**3**
Mean	**0.22**	**0.78**	**0.89**	**1.00**	**0.78**	**0.22**	**0.33**
%	**22**	**78**	**89**	**100**	**78**	**22**	**33**

CA = Combat Arms **SPT** = Support **DM: Y** = Yes I Am a Decision Maker

DMI: Y = Yes Decision Making is Important **DM: H** = Use Heuristic Decision Making

DM: Q = Use Quantitative Process Decision Making **ID AC** = IDed Adverse Consequences

ANOVA Results

A one-way analysis of variance was performed on the results of the two groups. The T test had a probability value of .284 (Figure 6), which isn't statistically significant for an alpha of .05, although the results are in the intended direction. Based on the theoretical models and the data from the designed experiment, ACs, accidents, mishaps, and mistakes could possibly be cut by 29% or more. Decision making and risk management could be improved even in a theoretical total information system.

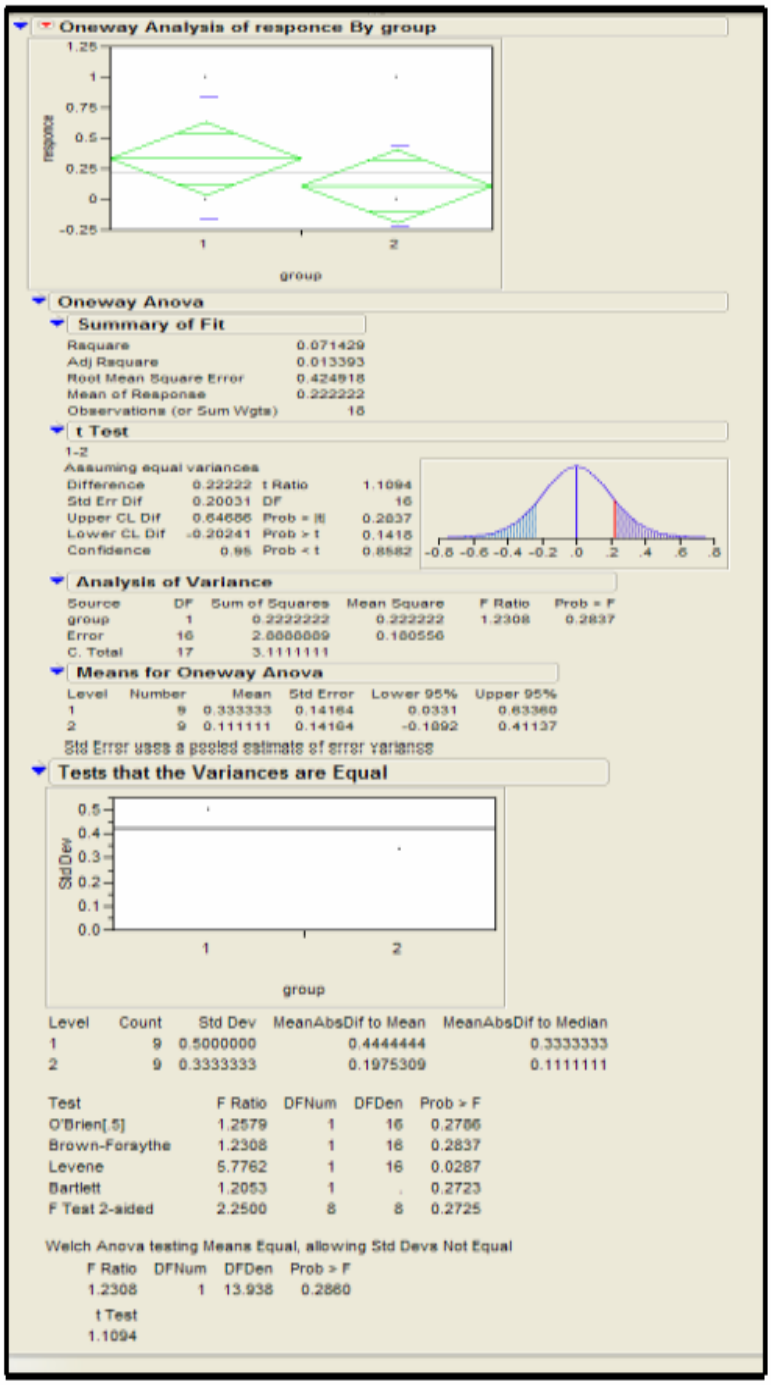

Figure 6. ANOVA Results

Binary Logistic Regression: Response1 versus Group

Link Function: Logit

Response Information

Variable	Value	Count	
Response1	1	4	(Event)
	0	14	
	Total	18	

Logistic Regression Table

Predictor	Coef	SE Coef	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Constant	-2.07944	1.06064	-1.96	0.050			
Group							
B	1.38629	1.27474	1.09	0.277	4.00	0.33	48.66

Log-Likelihood = -8.868
Test that all slopes are zero: G = 1.333, DF = 1, P-Value = 0.248

* NOTE * No goodness of fit test performed.
* NOTE * The model uses all degrees of freedom.

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	24	42.9	Somers' D	0.32
Discordant	6	10.7	Goodman-Kruskal Gamma	0.60
Ties	26	46.4	Kendall's Tau-a	0.12
Total	56	100.0		

Figure 7. Logit Loglinear Analysis

Logit Loglinear Analysis.

Not everyone agrees with using ANOVA for binary data since its test is based on the dependent variable being normally distributed. However, the LOGIT results in Figure 7 were similarly insignificant at a P value of .248.

Overall Findings

Phase IV.

The fourth phase is the accumulation of the results of the investigative questions to answer the research question.

1. Is there a practical significance to the identification / analysis of adverse consequences in a NCW system?

Yes, there is a practical significance to the identification / analysis of ACs in a NCW system because decision makers will need to identify and mitigate ACs in a NCW system. Teaching a practical heuristic model / process that has been identified in this study potentially could improve decision making by 29% or more.

2. What potentially will be the decision-making process in a NCW system?

    Most likely the decision making process in a NCW system will be a Recognition Primed Decision Model. Emphasizing AC identification and reverse mapping as in this model can augment decision making.

3. Will the decision-making process in a NCW identify / analyze adverse consequences?

    Recognition-Primed Decision Model does not appear to attempt to identify / mitigate ACs in decision-making unless changes are made.

4. Do military decision makers identify / analyze adverse consequences presently?

    Few do based on this research and most don't do it effectively. Previous to this study, no process or model was found for managers or leaders to identify / mitigate ACs in NCW decision-making.

5. How and to what extent can the identification / analysis of adverse consequences be a part of decision making in a NCW system?

    Emphasis on considering ACs and reverse mapping can be incorporated into managerial decision making process, risk assessments and training.

Research Question: Is there a need for military decision makers to identify / analyze adverse consequences as a function of the decision making process in a NCW system?

    Yes and potentially more so in the future.

    It is of interest to note that throughout the designed experiment, hypothetical

threats and adverse actions were encountered by the decision makers / test participants, most of which handle them very well despite the relatively low amount of participants that actually identified the AC. As discussed in the literature review, decision-making and risk management / assessments have excelled at identifying and mitigating external threats and adverse actions but appear to be absent on the identification and mitigation of ACs internal to the decision process.

V. Conclusions and Recommendations

Overview of Research

The general premise of this research is that decision making will increase in importance based on the transformation of the military towards NCW / Sense and Respond logistical, informational, command / control systems, and result in an increase of ACs, potentially resulting in an increase of accidents, major mishaps or in general system interruptions. Being able to quickly identify and mitigate ACs in decision making will be more valuable and needed for managers and leaders in the near future.

In the Legacy / cold war military, the need for information and decision making was mitigated by excess capacities, large inventories, redundant sub systems, and personnel or resources in general. Potentially in a NCW / Sense and Respond military there is a greater need for information and for decision makers to act on or use the information, resulting in an increase in decision making requirements.

Decision-making requirements in a NCW / Sense and Respond system may not increase in frequencies but rather increase in importance and impact, as available resources are lessened and the information flow and amount increases putting further demands on the decision makers. Also if the need to make decisions increases and ACs increase, the impact will be larger on the system with more implications, accidents, and system interruptions. It may be possible to mitigate or avoid the potentially negative impact of system interruptions and ACs that stem from decision making in a NCW / Sense and Respond system.

This study modeled the current and an alternative processes for identifying ACs in decision making using a three-step approach: by gathering research to first build a

conceptual model, then simulating the model's processes which served as a basis for the designed experiment, and concluding with a working model process.

Results of the Research

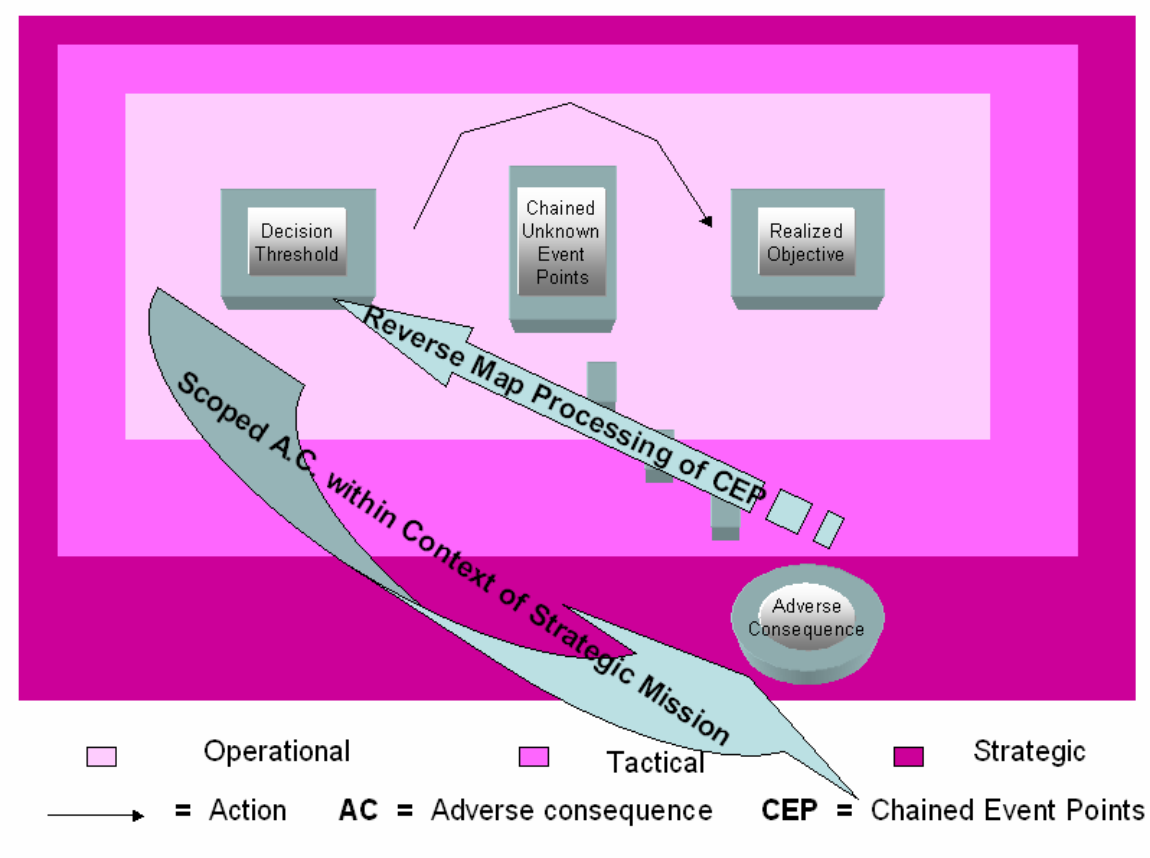

Figure 8. The Working Model

The alternative model is statistically similar in both the simulation and the designed experiment; see Figure 5 and Table 2. Potentially the working model is 37% effective at identifying the AC at a 4th moment CUEP. Results indicate that the working model increases success by 29% and is at least twice as robust at potentially identifying the AC. Further, the decision maker can handle more complex decision-making scenarios.

A one-way analysis of variance on the results of the two groups resulted in the T-test, probability value of .284, which is not statistically significant at an alpha level of .05 for quantitative research. However, this is predominantly a qualitative, exploratory study of a heuristic. A P value of .284 could be considered acceptable in an exploratory environment. For future research, a larger sample and conducting more tests are recommended.

Table 3. Designed Experiment Results of Both Groups Combined

Group 1A	CA	SPT	DM: Y	DMI: Y	DM: H	DM: Q	ID AC
Participants							
1		Y	Y	Y		Y	
2	Y	Y	Y	Y		Y	
3			Y	Y	Y		
4		Y	Y	Y	Y		Y
5		Y		Y	Y		
6		Y	Y	Y	Y		Y
7	Y		Y	Y	Y		
8		Y	Y	Y	Y		
9		Y	Y	Y	Y		Y
10		Y	Y	Y	Y		
11		Y	Y	Y		Y	
12		Y	Y	Y	Y		
13		Y	Y	Y	Y		
14		Y	Y	Y	Y		
15		Y	Y	Y	Y		Y
16		Y	Y	Y	Y		
17		Y	Y	Y	Y		
18		Y	Y	Y		Y	
Total	2	16	17	9	14	4	4
Mean	0.22	0.89	0.94	1.00	0.78	0.22	0.22
%	22	89	94	100	78	22	22

CA = Combat Arms **SPT** = Support **DM: Y** = Yes I Am a Decision Maker

DMI: Y = Yes Decision Making is Important **DM: H** = Use Heuristic Decision Making

DM: Q = Use Quantitative Process Decision Making **ID AC** = IDed Adverse Consequences

Table 3 reviews the combined results of both groups. 89% of the participants identified their basic career background as supporters. The two participants that identified themselves as combat arms did not identify the AC. 94% of the participants identified themselves as decision makers; the one participant that did not consider him or herself a decision maker did not identify the AC. 100% of the participants indicated that

decision making is important. 78% of participants identified that they use a heuristic approach in making decisions. 22% of participants stated that they use a quantitative model or process in making decisions; none identified the AC. In combining both groups, 22% of the participants identified the AC and 78% did not.

Limitations of the Research

The military has not completely or totally moved to a NCW system. This research is attempting to identify a future need and recommend possible action for something that has not occurred. The survey / designed experiment will not be completely representative of the all decision makers in the military due to limited resources and limitations of time/space. Decision making is very personalized to each decision maker and this, in part, fundamentally strengthens the military in general. This research is not attempting to replace the uniqueness of each decision maker's process of making decisions but rather attempting to prove or disprove a possible value-added tool to making decisions in a NCW system.

Future Research

This model potentially has far reaching implications. Possible improvement in decision-making and risk management could be realized with any person or group that makes decisions and mitigates risks. Future researchers may want to incorporate the working model in managerial risk assessments and decision-making processes. This research relied upon a hypothetical scenario in a designed experiment to attempt to verify and validate the model. If the time and resources were available, researchers could test the model with several actual scenarios. It is unclear if new managers would respond better to the model than managers with years of experience. Research could be

conducted to assess whether there is a higher success of using the model with new managers as opposed to experienced managers. Further research could be conducted on how experience, knowledge, and values play a part, and to what extent, in the process of identifying ACs in managerial decision making. It is possible that the approach is too complex for some managers and research could be conducted on how to make the model simpler and more user-friendly. The working model could be modified to incorporate statistical probabilities. Research could be done to adapt this model from a heuristic model to a quantitative model by incorporating statistical probability processes. Research involving artificial intelligence programming could benefit from the process of identifying and mitigating ACs. If the model's process could be transferred into computer recognized code or language, theoretically, an IT system that generates real time data could be programmed to identify ACs and the conditions, events that cause them and identify the problem and make recommendations to decision makers for the mitigation of the ACs before hand.

Summary

This research effort has attempted to shed light on the issue that decision making is more complex in a NCW system and that adverse consequences (AC's) will increase. The results of the simulation and the designed experiment suggest that there is merit in training decision makers in anticipating and recognizing AC's as a result of decisions made, which is different from external threats to the overall mission.

Appendix A. Sample of Decision Making Questionnaire Base Line Model Group 1B

Decision Making Questionnaire 1B

Please answer the questions honestly. Please answer yourself…Do not talk to anyone.

1. Which one best describes your basic job title? **Combat Arms** **Support**

2. Do you consider yourself a decision maker regarding your job? **Yes** **No**

3. Do you think decision-making is important? **Yes** **No**

4. In your experience would you say the decisions that you've made were based generally on an established quantitative process or model (Process / Model) or based on experience, common sense, and or intuitiveness (Heuristics)?

Process / Model **Heuristics**

Please take your time and answer the following hypothetical questions honestly.

5. You are a transportation platoon leader deployed to the Baltic country of Latveria. For many years local factions have been killing each other and have destroyed most of the infrastructure. The strategic mission is to protect life and limb of the local population and support the rebuilding of the war torn country. The tactical mission is to provide world-class combat and logistical force to protect life and limb of the local population and rebuild the infrastructure of the war torn country. Your operational mission is to provide your transportation resources and expertise to support all coalition forces in the area of operations.

You have been in theater for six months and the entire task force will rotate out beginning in one week. You are in charge and responsible for all of the transportation resources of the task force and it is in great demand. The task force has prioritized the

conflicting requirements and decided that the most important mission that must be accomplished in a short time is to support the engineer brigade in recovering 20 military bridges that can be folded and carried on a tank chasse. The bridges are located in the zone of separation, which was the battle area during the war and is full of minefields, unexploded ordinance and armed criminals. The bridges were put in place by our forces four years ago.

Because time is critical in this mission it has to begin tomorrow. You take a convoy on a two-hour trip to interface with the supported engineer unit. You meet the engineer Lieutenant in charge of his bridge recovery mission and go over with him the basic support plan you have for the mission. Basically you use your large trucks to carry the engineer tanks to the bridges located in the zone of separation and the bridges are folded onto the tanks and then the tanks place the bridges onto your trucks and you bring the tanks and the bridges back to the engineer's base and repeat until all bridges are recovered. Your sergeant tells you that the bridges and tanks have always been transported separately and is the excepted standard. The engineer Lieutenant shows you the locations of the 20 bridges and the one that will be recovered tomorrow. He gives you the coordinates to the bridge to be moved tomorrow and informs you that you will not need to take a tank out to the bridge tomorrow because there is a tank about a mile from the bridge that is supporting mine clearing operations and will meet you at the location at 0730. Additionally the Lieutenant is doing some important work for his commander and will meet you at the site at 0800. One of his best sergeants will be with the tank and is the expert anyway. You do not have time to conduct an on site recon of

the bridge to be removed tomorrow so is there anything left to do before you get some chow and bed down?

Don't read ahead. Don't change you answers. **Please list the top two things you decide need to be done if anything?**

A.----------

B.----------

The next morning you travel the two-hour distance to recover the bridge and tank. The route is hard traveling and the road is badly damaged with a lot of plants growing in and around the road. It doesn't look like it has been used for some time. Based on the grid location on the map you arrive at what you think is the area and see the bridge stretched across a stream at the bottom of a very deep ravine. The bridge seems to be in good shape and the dirt road that crosses it seems to be frequently used compared with the other road you came in on. It is now 0745 and you are 15 minutes late due to the poor road you came in on and nobody is there at the sight.

Don't read ahead. Don't change you answers. **Please list the top two things you decide need to be done if anything?**

C.----------

D.----------

The engineer Lieutenant arrives at 0800 and is leading the tank. "I see you made it…sorry I'm late with the tank; it is the first time we have been out here", the engineer Lieutenant says. The tank crew of four soldiers quickly gets to work digging out the bridge and you notice that besides the driver for the engineer lieutenant that's all the folks that they brought. You have two trucks each with two soldiers, one for the bridge and

one for the tank and your own driver for a total of five soldiers. Despite the fact that all five of the engineer soldiers are trying to dig out the bridge, the dirt is very hard and looks like it will take a long time. Even though it is still early, one of general order #1 is no soldier or convoy will be outside of a base camp after darkness. Is there at this time anything that needs to be done?

Don't read ahead. Don't change you answers. **Please list the top two things you decide need to be done if anything?**

E.----------

F.----------

Civilian vehicles start coming down the good road that goes across the bridge. The engineer's are too busy working and ignore what's going on. The trucks and cars seem to be full of farmers from a local village and stopped well short of our area since you already emplaced some of your soldiers as security. Your soldiers direct the traffic back where they came from. Although the civilians seemed curious and interested in what we were doing they were intercepted far enough away that they could not have seen or done any harm regarding the operation.

After about an hour the traffic dies down to almost nothing. It turns out to be a very hot day and you make sure your soldiers have all eaten and drunk plenty of water. Finally the bridge is freed from the concrete-like dirt that the ends were covered with. The tank moves into position to hook up with the bridge to fold it in half in order to place it on one of you trucks when something in a hydraulic line on the bridge breaks. Hydraulic fluid goes everywhere. The worst of it is that even though the bridge is folded and on the back of the tank as it's carrier; the tank can't extend the bridge to place it on

the back of the truck and it's stuck on the back of the tank. It's getting late and the tank will not be able to drive all the way back to base carrying the bridge before nightfall. You remember the route you took to get to the bridge that morning from the base camp and didn't recall seeing any low power lines or anything that might restrict the height load on the back of you truck. The engineer Lieutenant is very upset and concerned and informs his Captain of the situation who informs his boss who is a Colonel of the situation. The engineer Lieutenant tells you that his Colonel is on the radio and wants to talk to you. The Colonel says that the way he sees the problem is that it's a transportation problem and they recovered the bridge but can't drive the tank back to base with the bridge on top and could you be a hero and put both the tank with the bridge on the truck and pull it back to base. You think and know that both are not too heavy nor do you think the height is any big deal with no power lines or overpasses. Have you thought everything out careful enough? What, if anything, needs to be done?

Don't read ahead. Don't change you answers. **Please list the top two things you decide need to be done if anything?**

G.----------

H.----------

You make it back to base with the bridge and the tank and receive a coin from the engineer Colonel for accomplishing the mission. However based on the decisions you made or did not make there is or is not a large pile of cars and trucks at the bottom of the ravine that once had a bridge over it.

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Vita

Captain Mo Alsing is from Columbia, South Carolina. He was commissioned as a Second Lieutenant through the Reserve Officer Training Corps in 1995. He received an undergraduate degree in Political Science from Francis Marion University. CPT Alsing entered active duty in the Transportation Corps after attending Thomas M. Cooley Law School. After attending the Transportation Officer Basic Course in 1997, CPT Alsing served as a Transportation Platoon Leader for B Co, 123rd Main Support Battalion. He also served as the Movement Control Officer in 47th Forward Support Battalion while in Bosnia during Operation Joint Forge. Upon returning form Bosnia he took command of HHD, 123rd main Support Battalion. Following the Combined Logistics Officer Advance Course and the Combined Arms Service Staff School in 2000, CPT Alsing was assigned to HHD, 180th Transportation Battalion as the Battalion Supply Officer. CPT Alsing took command of 297th Cargo Transfer Company and deployed his company in April 2003 to Iraq in support of Operation Iraqi Freedom. While in Iraq he was assigned to HHD, 64th Corps Support Group as the Senior Transportation Officer until May 2004. In June 2004, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology. Upon graduation, he will be assigned to 4th Infantry Division to return to Iraq.

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Air Force Institute of Technology
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14. ABSTRACT

The general premise of this research is that decision making will increase in importance based on the transformation of the military towards Network Centric Warfare (NCW) / Sense and Respond logistical, informational, command / control systems. Additionally, this may result in an increase of adverse consequences, potentially resulting in an increase of accidents, major mishaps or, in general, system interruptions. Being able to quickly identify and mitigate adverse consequences in decision making will be more valuable and needed for managers and leaders in the near future. In the Legacy / cold war military, the need for information and decision making was mitigated by the large excess capacities, inventories, and redundant sub-systems and personnel or resources in general. Potentially in a NCW / Sense and Respond military there is a greater need for information and for decision makers to act or use the information, resulting in an increase in decision-making requirements. These may not increase in frequencies but rather increase in importance and impact, as available resources are lessened and the information flow and amount increases, putting further demands on the decision makers. Also if the need to make decisions increases and, additionally, adverse consequences increase, the impact will be larger on the system with more implications, accidents, and system interruptions. It may be possible to mitigate or avoid the potentially negative impact of system interruptions and adverse consequences that stem from decision making in a NCW / Sense and Respond system. A model is suggested for considering decision consequences.

15. SUBJECT TERMS

Decision making, adverse consequences, unintended consequences

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U	U	U	UU	66	19b. TELEPHONE NUMBER *(Include area code)* (937) 255-3636, ext 4511; e-mail: John.Bell@afit.edu